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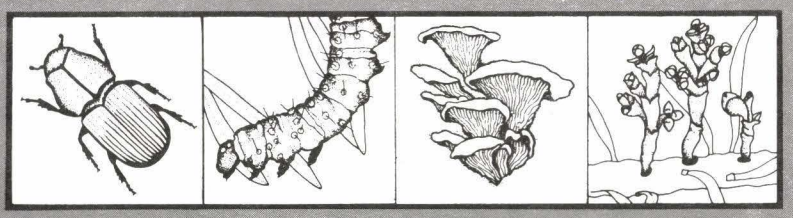

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MORTALITY FACTORS ASSOCIATED WITH LABORATORY REARED DOUGLAS-FIR TUSSOCK MOTH LARVAE: A CASE STUDY

by

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ABSTRACT

In conjunction with a proposed suppression project against the Douglas-fir tussock moth in northern Idaho, more than 1,000 larvae were collected from sample plots throughout the 32,000-acre treatment area. We had hoped to determine naturally occurring mortality factors which may have contributed to lower than anticipated population levels. Reared on artificial media, 71.5 percent of the larvae completed their development to the adult stage. Parasites accounted for 10.6 percent of the pre-adult mortality, native NPV only 3.1 percent; 12.9 percent died of other diseases or unknown causes. No single factor was identified as having resulted in unexpectedly low tussock moth populations in 1986.

INTRODUCTION

The Douglas-fir tussock moth, *Orgyia pseudotsugata* (McDunnough), is a major defoliator of true firs and Douglas-fir in western North America. As a native pest, it plays an integral role in the ecology of coniferous forests in the region (Stark 1978). Usually persisting at low population levels, the moth periodically erupts into outbreaks resulting in extensive growth loss, top kill, and mortality in infested trees (Mason et al. 1983).

In northern Idaho, outbreaks have occurred at near 10-year intervals for the past several decades, usually lasting about 4 years (Tunnock et al. 1985). Several years of population monitoring with pheromone traps led us to conclude that 1986 was probably year 2 of the current 4-year outbreak cycle (Dewey et al. 1985). A suppression project, using the naturally occurring nucleopolyhedrosis virus (NPV), was planned to reduce populations of the tussock moth before damage occurred. Using a hazard rating system developed by Stoszek et al. (1981), as well as other evaluation criteria, 32,222 acres of high risk and/or high value stands were identified for treatment. These high risk areas were geographically divided into 10 spray blocks. Three control blocks were randomly selected in adjacent areas (Fig. 1). In each block we located 10 three-tree sample clusters.

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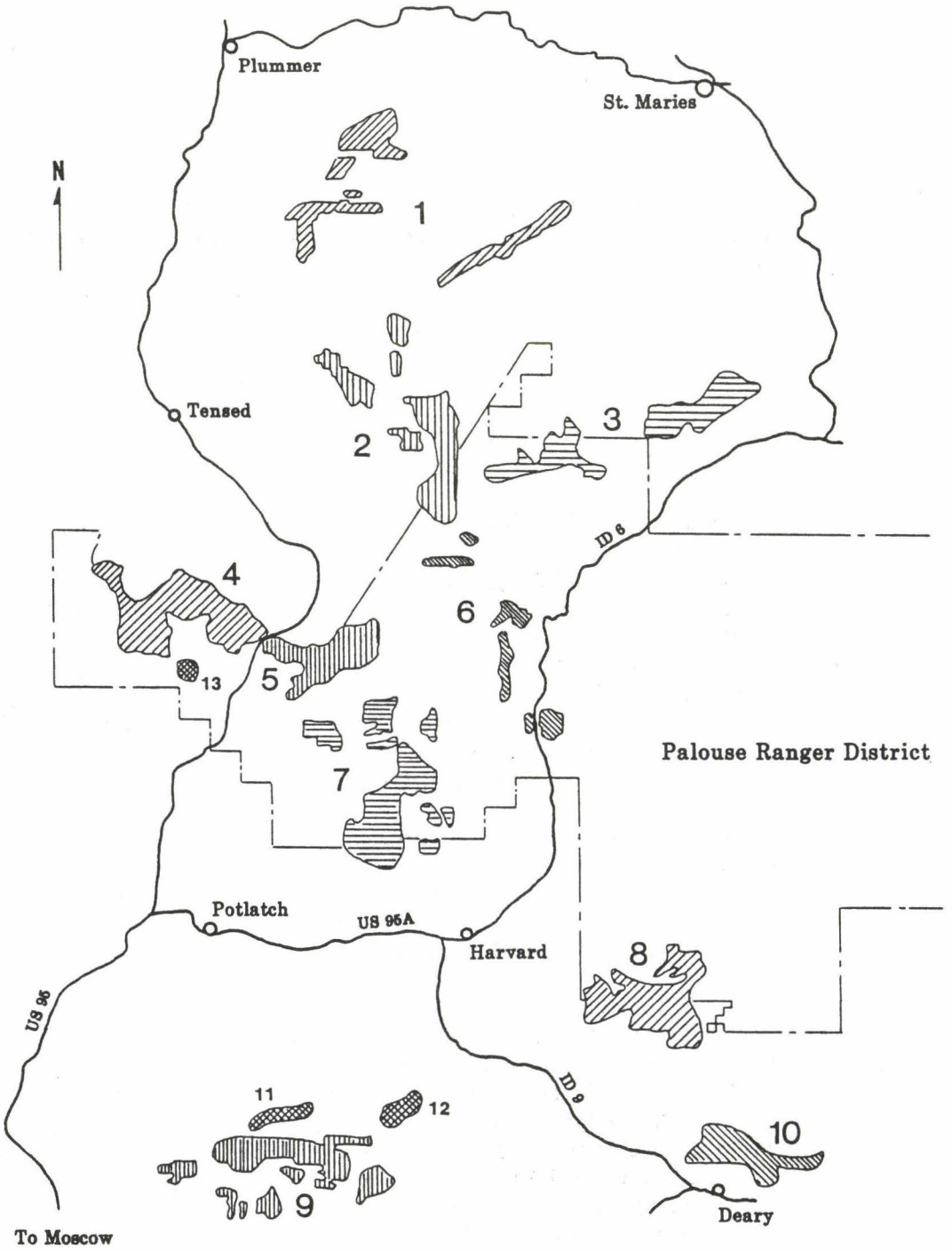

Figure 1. Block locations, DFTM virus project, 1986.

Prespray larval sampling, taken at midcrown, began on June 8. Larval populations were deemed too low to warrant control measures over the whole area, and spray application was terminated after one block was treated. We continued prespray and postspray sampling, however, to monitor the larval population throughout its developmental period. Prespray sampling was conducted when at least 50 percent of the larvae were in the second instar. Postspray sampling was conducted when at least 50 percent of the larvae were in the fourth instar. Larvae collected in the field were reared in the laboratory to determine the amount of natural virus and parasitism in the population. We hoped these data would help determine why the expected high population did not occur.

METHODS

We collected larvae from June 11 to June 19 by beating lower crown branches. Where possible, we collected at least five larvae per cluster in each of the 13 blocks. Larvae were collected from the treated block (block 5) 2 days after spraying. Seventy-five percent of the larvae collected at this time were in the second instar.

Another set of larvae was collected from June 24 to July 8 from the treatment block, the three check blocks, and also from blocks included in an NPV pilot project in 1985 (Stipe et al. 1986). These larvae were collected in conjunction with postspray and midcrown sampling. Seventy-two percent of the larvae were fourth instar and all larvae found were kept.

We reared a total of 1,045 larvae at the Forestry Sciences Laboratory, Moscow, Idaho. The windows in the lab provided enough light to simulate natural photoperiod. Temperature varied from 14 to 27 degrees Celsius.

Larvae were placed individually in 50- by 10-mm petri dishes until they reached the fourth instar. At that time they were placed in 100- by 15-mm dishes. We fed the larvae an artificial diet, which was prepared at the Forestry Sciences Laboratory in Corvallis, Oregon. Each petri dish contained a block (1 by 1 by 2 cm) of artificial diet which was changed weekly. To avoid transferring virus or any other contaminating agent, a sterile toothpick was used to add new diet and remove the old from each dish (Thompson and Peterson 1978). We labeled the dish of each larva with an identification code. Date of death or pupation and adult emergence was recorded. All parasites collected were sent to Torolf Torgerson, Forestry and Range Sciences Laboratory, LaGrande, Oregon, for identification. Dead larvae and pupae that did not emerge were sent to Roy Beckwith, Forestry Sciences Laboratory, Corvallis, Oregon, to determine incidence of virus or other causes of death.

RESULTS AND DISCUSSION

Of 1,045 larvae reared, 747 (71.5 percent) emerged as adults. The male/female ratio was approximately 1:1 (51 percent male to 49 percent female). One hundred eleven larvae (10.6 percent) died as a result of parasitism. Forty-nine larvae died of NPV infection, of which 17 were from the treated block. Another 135 died of other agents such as bacterial diseases, fungi, yeasts, or unknown causes. Three were lost during shipping so cause of their deaths could not be determined. These results are shown by block in table 1. Figures 2a and 2b show the proportion of larvae killed by parasites and virus to total larvae collected for each block. Figure 2a combines the data from both sets of larvae collected for blocks 5, 11, 12, and 13.

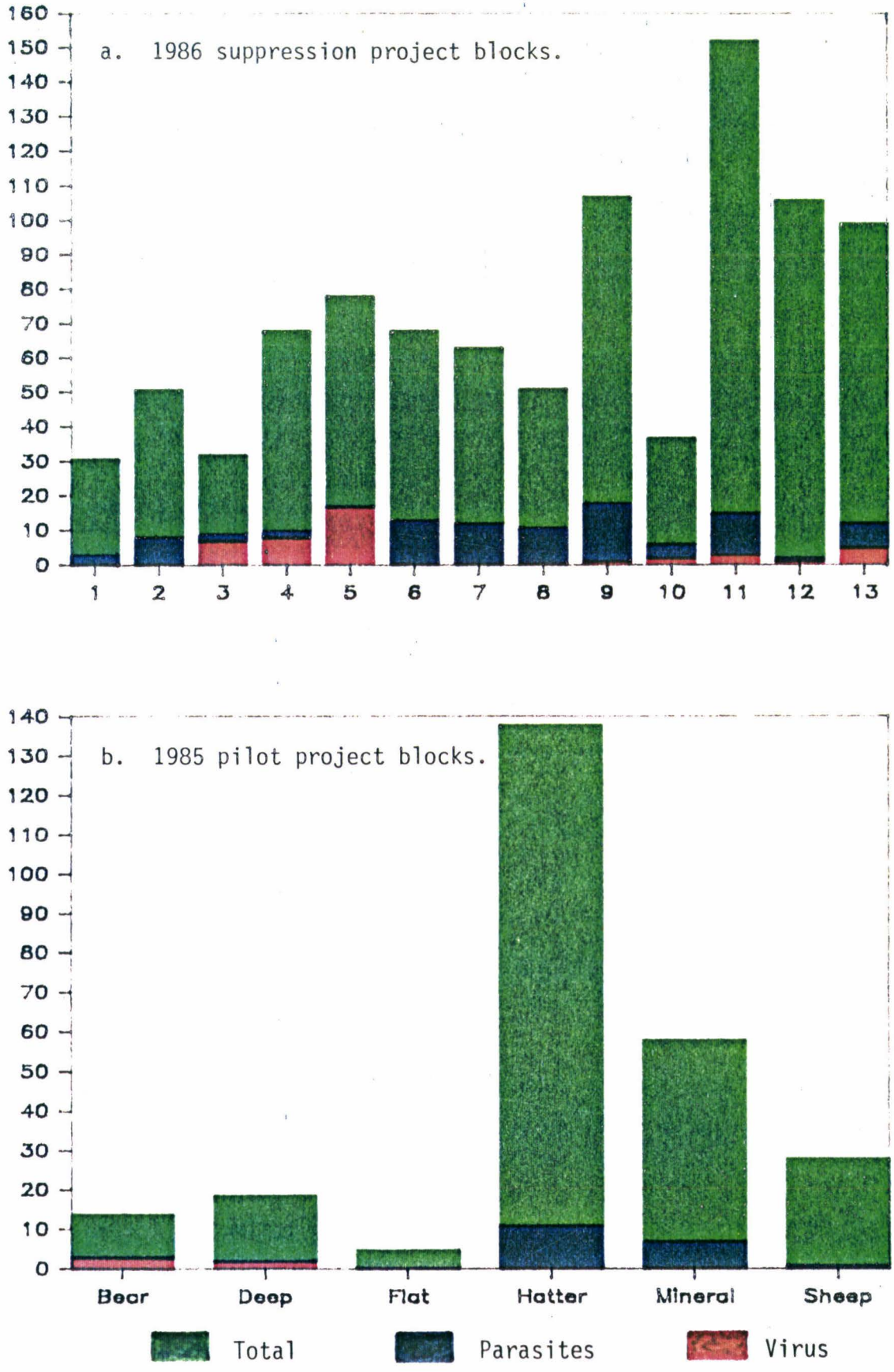

Figure 2. Number of larvae dying of parasitism and virus disease compared to total larvae.

Table 1.--Results of Douglas-fir tussock moth larval rearing by block

Date	Block	Total larvae	Adults F	Adults M	Parasite killed No.	Parasite killed %	Virus killed No.	Virus killed %	Other dead
				1986 Suppression Project Blocks					
Prespray data									
6/18	1	28	8	13	3	11	0	0	4
6/19	2	43	13	16	8	19	0	0	6
6/19	3	23	5	8	2	9	7	30	1
6/14	4	58	25	19	2	3	8	14	4
6/12	5*	50	8	7	0	0	16	32	17
6/16	6	55	16	17	13	24	0	0	9
6/18	7	51	15	17	12	24	0	0	7
6/17	8	40	11	16	11	28	0	0	2
6/13	9	89	28	31	17	19	1	1	12
6/15	10	31	10	9	4	13	2	6	5
6/11	11	96	36	34	6	6	3	3	17
6/11	12	60	24	23	0	0	1	2	12
6/11	13	81	26	34	7	9	5	6	9
Postspray data									
7/8	5*	11	1	4	0	0	1	9	5
7/7	11	41	17	12	6	15	0	0	6
7/7	12	44	21	20	1	2	0	0	2
7/7	13	6	3	2	0	0	0	0	1
				1985 Pilot Project Blocks					
6/25	Bear**	11	4	4	0	0	3	27	0
6/25	Deep**	17	6	7	0	0	2	12	2
6/24	Flat**	5	2	2	0	0	0	0	1
6/24	Hatter	127	50	59	11	9	0	0	7
6/26	Mineral	51	22	16	7	14	0	0	6
6/26	Sheep	27	17	9	1	4	0	0	0
	TOTAL	1,045	368	379	111	10.6	49	3^	135

*Block treated with NPV 1986.
**Blocks treated with NPV 1985.
^Percent virus overall excluding block 5.

Early instar larvae from the treated block (block 5) had the highest mortality due to virus (32 percent). Virus-caused death in blocks 3 and Bear were nearly as high (30 percent and 27 percent). However, these results may be biased due to the small sample taken. In other blocks, percent mortality due to virus ranged from 0 to 14 percent.

Larvae from blocks 6, 7, and 8 showed the highest mortality due to parasitism (24-28 percent). In other blocks, parasitism ranged from 0 to 19 percent. Since we did not collect cocoons for rearing and some parasites attack only prepupae or pupae (Torgersen 1977), actual field mortality due to parasitism may be higher than we have reported.

The parasites identified were five species of ichneumonids, two braconids, and a dipteran (Table 2). The most abundant parasite, *Hyposoter masoni* Torgersen, was recently described by Torolf Torgersen (1985). *Phobocampe pallipes* (Provancher), *Phobocampe* sp., and *Meteorus tersus* Mueseback were common parasites recorded from the 1974 outbreak near Coeur d'Alene, Idaho (Tunnock et al. 1976). *Hyposoter fugitivus* (Say) is more common in the southern portions of the host's range (California and southern Oregon). *Apanteles* sp. and *Exorista mella* (Walker) have been recorded from various locations throughout the host's range (Torgersen 1981). *Mesochorus* sp. is a hyperparasite of *Phobocampe*.

Table 2.--Parasites reared from Douglas-fir tussock moth larvae

Order, Family, Species	No. found	Location (blocks)
Hymentoptera		
Ichneumonidae		
Hyposoter masoni	49	1,2,3,6,7,8,9,10,11,13,Hatter,Mineral
Phobocampe pallipes	35	6,7,8,9,10,13,Hatter,Mineral,Sheep
Phobocampe sp.	15	2,4,6,7,8,9,10,11,12,Hatter
Hyposoter fugitivus	3	4,7,13
Mesochorus sp.	1	4,7,13
Braconidae		
Meteorus tersus	6	6,7,11,Hatter
Apanteles sp.	1	9
Diptera		
Tachinidae		
Exorista mella	1	11

CONCLUSION

Fewer male moths were caught in pheromone traps in 1986 than in 1985 (Kohler et al. 1987). Fall egg mass counts were also lower in 1986. These data, along with our low midcrown larval samples, would indicate the Douglas-fir tussock moth population is declining. Our rearing results suggest the decline cannot be contributed to viral disease.

Similar conclusions were found concerning the 1974 outbreak near Coeur d'Alene, Idaho (Tunnock et al. 1976).

We did not look at the whole spectrum of egg, larval, and pupal parasites, nor do we have data to compare parasitism of previous years. We cannot, therefore, know exactly what effect parasites have had on the decline of the tussock moth population. Though overall percent parasitism was relatively low, it may have been higher than in 1985.

At low moth population densities, natural controls may account for as much as 90 percent larval mortality and kill at least 75 percent of the pupae and eggs each generation (Wickman et al. 1981). Though many of these factors were not considered in this study, we did observe natural mortality totaling nearly 30 percent. Those control factors we observed, along with those we did not, have resulted in tussock moth populations much lower than anticipated.

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